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Bell is in favor of the hypothesis of Dr. Sterry Hunt, who regards it as due to terrestrial radiation, and analogous to the formation of hoar-frost on the surface of the ground in clear weather. A similar opinion was held by Arago, but this theory does not explain all the phenomena; and the views of Zschokke, that the anchor-ice is formed on the surface and carried to the bottom by the current, seem to agree better with the facts. C. W. Weber and J. Rae agree with this theory. It is doubtful whether water is so diathermal for dark rays that the radiation should have any effect on the formation of anchor-ice.

Of great interest are Bell's remarks and observations on the long fissures which remain open throughout the winter. He proves that the changes of temperature have no influence upon their width. They form every winter in the same situations, and generally between the extremities of points on opposite sides of the water. He considers it probable that the progressive lowering of the water going on during the winter produces a tension on such places sufficient to keep the fissures open.

Finally, Bell explains the remarkable rings and dikes of bowlders caused by the action of the ice. In ponds which freeze to the bottom, bowlders are incorporated in the ice. As the ice is evaporating at its surface, while accessions of water lift the ice, the bowlders are raised and gradually carried toward the periphery. On large lakes the drifting ice is pressed against the shores, and thus forms dikes of bowlders.

MÜLLER'S SCIENCE OF LANGUAGE.

THE appearance of the concluding part of Dr. Müller's great work on linguistic science, which has occupied ten years in its publication and of course a much longer time in its preparation, affords a good opportunity for considering this important contribution to science as a whole. In speaking of it as concluded, however, the term must be understood as applying to the original plan, which contemplated only three volumes. In this sense, the author regards his work as completed. But, as we learn from the preface to the latest portion, he purposes adding two supplementary volumes, one of which will be occupied with the analytic and the so-called 'mixed languages,' as well as with new idioms, extinct and living, of undetermined position, while the other will comprise the materials which have accumulated during the past ten years.

Like the other inductive sciences, — and perhaps even more than the majority of them, —

Grundriss der sprachwissenschaft. Von DR. FRIEDRICH MÜLLER. Vienna, Alfred Holder; London, Trubner. 8°.

comparative philology has been a rapidly growing science. No better evidence of this fact can be found than in the comparison, to which the author himself invites us, of his work with that of his noted predecessors, Professors Adelung and Vater, whose well-known 'Mithridates' presented the first general survey of languages ever attempted on a scientific plan. That great work, of which the last volume appeared in 1817, is justly deemed a monument of erudition and laborious research. The authors undertook to give an account of all known languages, with (wherever practicable) the Lord's Prayer as a specimen of each, translated and carefully analyzed. The work was as well accomplished as was possible at the time. But the necessary materials were to a large extent lacking, and the principles of the science were imperfectly understood. During the sixty years which have since elapsed, the progress of research has not only added largely to the data, but has developed many laws of the science, and in a great measure revolutionized its character. Exploring expeditions, missionary labors, and the study of ancient monuments have more than doubled the number of known idioms. At the same time, the profound investigations of many eminent scholars, in Europe and America, have elucidated the principles which lie, or seem to lie, at the foundation of the science. Some qualification is necessary in this statement, for in the science of language, as in other sciences, new discoveries are constantly appearing, which alter materially the aspect of what was deemed to be established truth. Not the less, however, is it certain that a vast progress has been made since the time of Adelung and Vater. Some able and practised hand was needed to gather up the immense mass of scattered material, and to frame a structure which should represent the present condition of the science, and make a solid platform on which other inquirers might safely build. No one, certainly, could be better fitted for this office, by experience and talent, than the distinguished scholar to whom we owe the linguistic portion of the history of the Novara expedition, and the well-known 'Algemeine Ethnographie,' which has long been a standard work.

In the brief preface to his first volume, Dr. Müller remarks that his work is designed specially for the use of academic lecturers and for students who desire the means of self-instruction. He has therefore purposely avoided the more popular and discursive method of books intended merely for general reading, and has adopted in preference the concise and systematic form of treatises devoted to the exact sciences. Throughout the greater portion of his work he has adhered strictly

to this scientific method, which, as he justly considers, can alone give to such a work a permanent value. In the introduction, however, which occupies about a third part of the first volume, he has allowed himself more freedom, and has entered into many disquisitions which will interest the general reader, and will doubtless evoke much discussion and some dissent. He treats of the aim and limits of linguistic science; of the relation of speech to thought; of the origin of language, including the great question of the unity or plurality of beginnings; of the development of speech; of its material and formative parts; of the proofs of kinship among languages; of their classification, according to the various systems which have been proposed by philologists; of the elements of speech,—the root, the word, the sentence; of articulate sounds (phonology); of the expression of thought by writing, and of the influence of writing on the development of language. This list of topics is much abridged, and gives only an imperfect idea of the many subjects on which the author touches in this important introduction, in which he has condensed the conclusions of long-continued study and profound analysis.

In his classification he has sought to combine the ethnological and philological methods, and thus to link his earlier 'General ethnography' with the present work. The attempt was a natural one, but cannot be said to be altogether successful; and it is easy to see that the author himself, whose candor throughout is transparent, was finally not altogether satisfied with it. In the classification of races he selects (as in his 'Ethnography') the hair as the best criterion. He divides all mankind primarily into two classes,—the 'woolly-haired' (*ulotrichi*) and the 'smooth-haired' (*lissotrichi*). Each of these classes is again subdivided into two divisions. The woolly-haired class comprises the 'tuft-haired' (*lophocomi*) and the 'fleecy-haired' (*eriacomi*); while the smooth-haired races comprehend the 'straight-haired' (*euthycomi*) and the 'wavy-haired' (*euplocomi*). Other high authorities, including St. Hilaire, Bory de St. Vincent, and Huxley, have adopted the hair as the best primary characteristic for distinguishing the races. But while the epithets drawn from it are excellent descriptive terms, they are found in practice, like those derived from the shades of color and the shape of the head, to be far too wavering and uncertain to serve the purposes of a true scientific classification. Such is the conclusion of Prichard, Peschel, Quatrefages, Wilson, and other able ethnologists who have tested these methods.

To this opinion Dr. Müller's own matured views plainly tend. Though he formally preserves

throughout his work—evidently for the reason that has been suggested—the four classes distinguished by the hair, he practically deserts this classification for that which his studies and philosophical insight have convinced him to be the only satisfactory and proper one,—at least for a philological treatise,—namely, the genealogical classification, based on the distinction of linguistic stocks. These stocks are, in fact, in comparative philology, what the elementary substances are in chemistry,—the sole and sufficient ground of a true scientific classification. The question of the origin of these stocks, or linguistic families, is too extensive and too much contested to be here considered; but that their distinction and determination constitute the primary element and foundation of linguistic science is a definite conclusion, for which the high authority of Dr. Müller may now be claimed.

The main body of the work consists of careful analyses of the phonetic and grammatical systems of all the languages whose sounds and grammar are known. In most instances—and, in fact, wherever compositions in the language are found—specimens of the text are given, with inter-linear translations, and with annotations explaining every grammatical peculiarity. Such translations are, of course, the best test of the author's knowledge of the language. The labor required to master so completely the intricacies and peculiarities of this large number of idioms—from the monosyllabic Chinese and Anamese, with their variety of tones and positions, to the multitudinous inflections of American tongues—must have been enormous; nor would mere industry have been sufficient, without large experience, and what may fairly be termed linguistic genius. The first volume comprises the languages of the woolly-haired races, and is devoted almost entirely to the African tongues. The single exception is the Maför language, spoken on the north-west coast of New Guinea. The Maför people are not more woolly-haired than many other tribes of Melanesia. But as the latter speak 'mixed languages,' mainly of the Malaisian type, they are relegated to the 'Malayan race,' which is included among the smooth-haired races. Thus the classification by the hair breaks down on its first application; and we cannot be surprised that the author, hampered at the outset by his earlier ethnological theories, is glad, as his work proceeds, to escape from them, and restrict himself entirely to the genealogical classification.

The second volume opens with an interesting description and comparison of the very peculiar and in some respects highly organized Australian languages, which are shown conclusively to be-

long to a single stock, and not to be allied either to the Malayan or the Dravidian tongues, to which some authorities have sought to refer them. The languages of the 'hyperborean races,' extending along the arctic coasts, from the Yenisean tribes to the Chukchi and the Eskimo, lead naturally to the proper American idioms. The discussion of these idioms must be deemed the least satisfactory portion of the work, not from any failure in the author's research or accuracy, but from the impossibility of condensing his materials into the limited space allowed for them. The linguistic stocks of this continent are at least twice as numerous as those of all the rest of the world. Their grammatical characteristics vary widely, and are of the highest interest. As Prof. Max Müller has well pointed out, these languages "can tell us quite as much of the growth of the human mind as Chinese, or Hebrew, or Sanscrit." Some of the stocks or families — as, for example, the Algonkin, the Dakota, and the Maya — comprise many distinct languages, which have been carefully studied and compared by some of the ablest philologists of Europe and America. In purely scientific value, apart from merely extraneous grounds of interest, the Algonkin family far surpasses the Hamito-Semitic stock. Yet while the latter occupies two hundred pages, the former is restricted to thirteen. It is as though, in a treatise on zoölogy, eighteen pages were given to the horse, as being a biblical animal, and only one page to the elephant. It must be admitted that in the present condition of linguistic science this discrepancy could not well have been avoided without making the work unwieldy and unsalable; and it is fair to add that the descriptions of the American languages, so far as they extend, are for the most part remarkable exhibitions of analytic skill.

A most admirable account is given of the great Malasian family, which occupies, with the exception of the Australian and some Papuan tongues, the vast island world from Madagascar to Hawaii. This is followed by the languages of the 'North Asiatic' or Mongolian race, extending from Lapland and Hungary to Japan and the Indo-Chinese peninsula. The Nubian or smooth-haired African race succeeds, followed by the primitive languages of Hindostan, composing the Dravidian family. The greater portion of the third volume is occupied with the languages of the so-called 'Mediterranean race.' This is a purely geographical designation, including populations so widely distinct in physical traits and in language as the Indo-Europeans, the Hamito-Semitic nations, the Caucasian tribes, and the Basques. To these languages, which were the first

to attract the attention of philologists, the author has devoted special care. The perplexing variety of Caucasian tongues is reduced by him to two, or at the most three, families. The curious and elaborate inflections of the Basque are analyzed and set forth with remarkable clearness. Those students of language who are accustomed — as too many are — to regard the whole of philological science as summed up in the two families of the Indo-European and the Hamito-Semitic stocks, will here find an example of an indefatigable and large-minded scholar, who can equal if not surpass them in their special studies, while his wider view embraces, as that of every thorough philologist should do, a knowledge of the chief characteristics of all the other families.

The work lacks an index, which will doubtless be furnished with the supplementary volumes. There is another and a much more important deficiency, which we may hope will be supplied in this forthcoming portion. In his survey of languages, the author has restricted himself almost entirely to idioms of whose grammar something is known. Those tongues of which we possess merely vocabularies are to him as though they did not exist. He does not even condescend to name them. In his view, the life of a language is in its grammatical forms; and only by the comparison of such forms can we be made certain that two languages are, or are not, akin. The first of these propositions is unquestionably true; the other is opposed to much evidence and to the author's own example. Gallatin's great work, the 'Synopsis of Indian languages,' owes most of its value to its comparative vocabularies; and his classification, based mainly on these vocabularies, has proved substantially correct. It is purely by lexical comparison that Dr. Müller has been able to establish the unity of origin of all the Australian tongues. No doubt this method has been greatly abused by incompetent writers. It needs to be applied, like all other tests, with scientific knowledge and caution; but, when so applied, it will be found entirely conclusive. Employing this method, the author will be able to give us, for the first time in the history of philological science, a nearly complete list of linguistic stocks, which, instead of the 'one hundred' mentioned in his introduction (p. 77), will probably be found to number nearly three hundred; and he will thus at length place this science on a truly philosophical basis. If to this he would add a series of language-maps, similar to those of which Mr. Cust, in his volume on the 'Modern languages of the East Indies,' has given us admirable examples, his work would be completed in a manner which would leave little to be desired. Even without these additions, the

three volumes, as they stand, form a compendium of the greatest value, indispensable to all who are engaged in any department of linguistic study.

H. HALE.

PROFESSOR GAGE of Cornell university has recently issued a pamphlet consisting of notes on microscopical methods for the use of laboratory students in the anatomical department of that institution. They are designed to accompany the notes on histological methods which were published last year, and to give only the main facts and principles relating to the microscope and to its manipulation, which seem indispensable for the successful study of elementary histology. In these notes the microscope and its parts are described, and advice given as to its care, and also the care of the eyes, which are apt to suffer unless special precautions are taken to protect them. Professor Gage advises that both eyes be kept open, and the labor divided between the two eyes, using one eye for observing the image a while, and then the other. He recommends the use of an eye-screen made by pasting black velveteen on bristol-board. The body of the microscope is received in a hole cut in the middle of the length of the screen and nearer to one side. The eye which is not in use looks at the black surface, without any strain or injurious effect. The micrometer and its use are made clear, and a description given of the camera lucida and the methods of drawing the objects seen in the field of the microscope. The differences between adjustable and non-adjustable objectives, and their advantages and disadvantages, are concisely treated, as are also immersion objectives, and Zeiss' new apochromatic objectives. This name has been given to his objectives made of new kinds of glass. They are made adjustable and non-adjustable, dry, and for water and homogeneous immersion liquids. Altogether, Professor Gage is to be congratulated on having put a large amount of valuable information into a very small space, and that, too, without having sacrificed clearness of description. The figures, eleven in number, aid very materially in elucidating the text.

—Prof. John A. Ryder of the Biological department of the University of Pennsylvania has recently had a new microtome constructed. It cuts serial sections in ribbons, and is very compact, occupying a space of only eight inches by four. The sections produced are cut flat, and are not parts of a hollow cylinder. The thickness to be cut can be adjusted by a simple device, and ranges from $\frac{1}{10000}$ of an inch or .0025 mm. up to $\frac{1}{400}$ of an inch or .0625 mm. The knife, an ordi-

nary razor, admits of being placed at any angle, as in a sledge microtome. The successive sections are cut as rapidly as the operator can move his right hand up and down through a distance of three inches. This new instrument was devised in order to provide a simple, compact tool, adapted to class-work, where many sections are required, and for embryological, histological, pathological, and botanical research, at far less cost than that of the best sledge microtomes, and, though constructed very differently from the latter, is equally accurate. Recently great improvements have been added, so that it can be used as a rapidly cutting, freezing microtome, or in cutting celloidin sections. With this new device, an object several inches in length may be embedded entire, as a single block, and cut up into a continuous series of sections by the ribbon method. Cutting a large block into a series of sections in this way is not possible with any other microtome yet devised. The range of capability of this new aid to research is therefore very great, and will doubtless be appreciated by teachers who wish to supply their pupils with an abundance of illustrative material, with a device fully three times as rapid in action as the Thoma made by Yung, and with all its capabilities for adjusting the knife and block. It is admitted by several competent histologists, who have examined it, to be the most practical instrument yet devised.

—Prof. J. Vilanova y Piera, of the University of Madrid, who has undertaken to edit a polyglot dictionary of geological and geographical terms, has invited Dr. John C. Branner, professor of geology in the University of Indiana, to take charge of the Portuguese part of that work. Besides the usual studies of the language, Dr. Branner has acquired a practical acquaintance with the Portuguese during two visits to Portugal and a residence of nearly eight years in Brazil, where he was assistant geologist upon the Imperial geological survey. In the preface to the Spanish part of the polyglot dictionary, Professor Vilanova y Piera says that such a work was first suggested to him by American geologists at a meeting of the International congress of geologists.

—The U.S. hydrographic office has published a complete list of the charts, plans, and sailing-directions that had been published up to the end of 1886. The catalogue will be a valuable book of reference to students of American geography. The supplements to the sailing-directions, which were issued in December, 1886, contain a collection of all the additional information which has from time to time appeared in U.S. 'Hydrographic notices' and 'Notices to mariners.'